STAINLESS STEEL POWDERS AND ARTICLES PRODUCED THEREFROM BY POWDER METALLURGY

BACKGROUND OF THE INVENTION

This invention relates to atomised high alloy powders of compositions which when used to manufacture sintered articles, provide metal articles having a good corrosion resistance, compared with components produced from conventional stainless steel powders, and in addition having exceptionally good wear resistance.

Stainless steels can be classified in a variety of ways. However, the key differences in properties are determined by the type of matrix created in the steel after processing and possibly, heat treatment. Alloys based around predominantly ferritic, austenitic, and martensitic matrices are all in common use. In addition, duplex steels, typically having a matrix containing 50/50 mix of austenite and ferrite, are available.

Martensitic stainless steels are essentially ferrous alloys containing chromium and carbon. They can be made fairly hard and wear resistant by development of a martensitic matrix, sometimes strengthened by precipitates, but are generally only resistant to corrosion in relatively mild environments due to their low chromium contents.

Austenitic stainless steels are ferrous based alloys containing moderate additions of chromium but with very little carbon. In addition liberal amounts of austenite stabilising elements, such as nickel, manganese and nitrogen, are added. The common austenitic grades contain a minimum of 6% nickel. In general, these alloys achieve better corrosion resistance than the martensitic grades. This is due primarily to their higher chromium contents. However, powder metallurgy produced austenitic stainless steels are susceptible to fairly severe crevice type corrosion at certain sintered densities. In addition since the austenitic grades are generally soft they cannot achieve good wear resistance.

Conventional ferritic stainless steels are ferrous based alloys containing primarily large additions of chromium with low concentrations of carbon and nickel. These alloys show excellent corrosion resistance especially at the higher chromium levels (superferritic) with a reduced tendency to the crevice type corrosion found in austenitic stainless steels. However, the ferritic type matrix is extremely soft and has a poor work hardening response. Consequently these alloys develop poor wear characteristics.

In summary, austenitic grades provide good corrosion resistance but have a tendency towards crevice type corrosion in powder metallurgy produced components. In addition, these materials tend to be more highly alloyed than ferritic grades, with a similar level of corrosion performance, due to the requirement for large additions of nickel to stabilise the austenitic matrix. Martensitic grades provide good wear resistance but only moderate corrosion resistance. Finally ferritic grades offer potentially excellent corrosion resistance but poor wear resistance due to the poor mechanical properties of ferrite.

In general it has been the practice when producing conventional stainless steel materials for applications requiring good corrosion resistance and ease of fabrication to avoid the use of chromium in large quantities due to the fact that a fully austenitic matrix cannot be maintained without large nickel or manganese contents also being present. In the practice of this invention no nickel or manganese is required to provide a material with excellent corrosion properties and powder metallurgy processing avoids any problems with ease of fabrication. Furthermore, in conventional austenitic or ferritic stainless steels the addition of large quantities of carbon is also to be avoided due to a reduction in corrosion resistance by the well known phenomenon of sensitisation (reduction of the matrix chromium content in the vicinity of the grain boundary by carbide precipitation at the grain boundaries).

PRIOR ART

A number of workers in this field have previously investigated the addition of high chromium levels to alloys containing various other elements. (U.S. Pat. No. 3,993,445) teaches that when high chromium levels (12–30 wt %) are used to produce a ferritic stainless steel densities of less than 80% of full density can provide good corrosion resistance. However, the alloys disclosed in that patent have no more than 0.15 wt % of carbon.

Other workers in the field for example U.S. Pat. No. 4,765,836, EP-A-0348380 and WO/8604841 have disclosed the use of powders containing high chromium, high carbon, and strong carbide formers, and claim good corrosion resistance with good wear resistance. However, these patents teach the use of these powdered materials for hot isostatic pressing, forging, and extrusion. These processes all require the application of high pressures during heating in order to produce a nominally 100% dense material which is then further heat treated in order to produce the required properties. Densification necessarily involves deformation so an article of dimensional stability is not achieved.

Specifically U.S. Pat. No. 4,765,836 teaches that the alloy composition disclosed in that patent produces a martensitic structure when heat treated.

European patent 0 348 380 also teaches the use of high chromium materials with carbide forming alloying elements matched by the presence of sufficient carbon to form carbides. However, this patent includes the application of pressure during heating, and material homogeneity due to hot working during or after full densification. The only example describes a six-fold degree of deformation during forging, following by further heat treatments.

PCT WO/8604841 also discloses hot isostatic pressing of high chromium materials. Furthermore, the alloy compositions do not contain strong carbide formers. The composition allows the addition of up to 2.3 wt % nickel.

Finally, U.S. Pat. No. 4,808,226 discloses materials with chromium contents up to 14 wt % consolidated by applying pressure during the heating stage. Furthermore a specific powder size range of 75–105 microns is employed. This size range is used in order to produce a metastable austenitic powder.

SUMMARY OF THE INVENTION

A primary objective of the invention is to provide articles from stainless steel alloy powders which may include the addition of free graphite powder, and to provide powder suitable for making such articles, which articles have a combination of high wear resistance and good corrosion resistance and preferably are produced to a required dimension without further heat treatment or thermo mechanical working giving rise to significant deformation and a change in dimensions. By further heat treatments we mean such heat treatments as would lead to a change in metallurgical structure.

We have found that the main objects can be achieved by cold pressing and sintering powder containing large quantities of chromium (in excess of 14 wt %) and a controlled